MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EET2066 – POWER TECHNOLOGY

(RE)

14 MARCH 2020
2:30pm – 4:30pm
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 3 pages excluding cover page with 4 Questions only.
2. Attempt **ALL (4)** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1 [25 marks]

(a) Briefly describe **THREE (3)** classifications of power semiconductor devices based on degree of controllability in the power circuit. Provide an example for each category. [6 marks]

(b) Figure Q1(b) shows a series connection of two power diodes. Discuss the limitations of this circuit and hence propose a solution to overcome the problems. [6 marks]

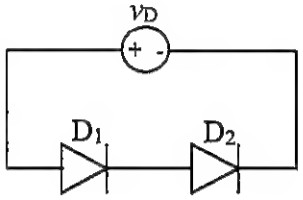

Figure Q1(b)

(c) Figure Q1(c) shows the switching waveforms of a power BJT terminated with resistive load. The transistor operates at 40% duty cycle with $\tau_{on} = \tau_{off} = 2\mu s$, $\beta = 100$ and $V_{BE(on)} = 0.7$ V.

Calculate the power loss dissipation occurred in the switch. [13 marks]

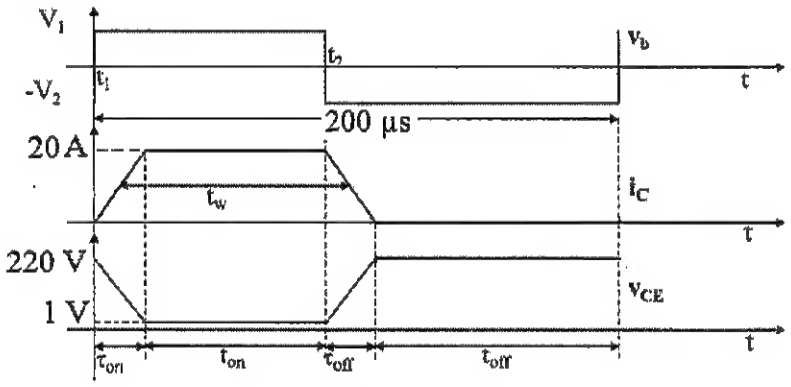

Figure Q1(c)

Continued...

Question 2 [25 marks]

(a) Briefly describe for the following terms:

(i) Commutation [2 marks]

(ii) Line commutation [2 marks]

(iii) Forced commutation [2 marks]

(b) Figure Q2(b) shows a single phase half wave rectifier with resistive load.

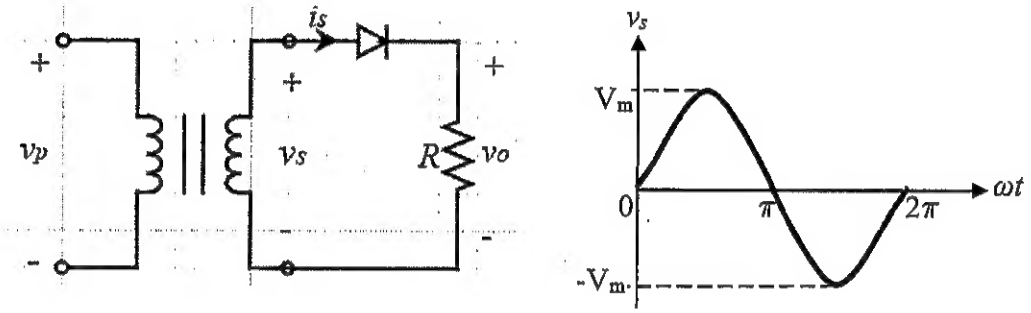

Figure Q2(b)

(i) Derive and show that average output voltage is expressed as $V_{ave} = 0.318V_m$. Hence, determine the average output current expression (I_{ave}).

[5 marks]

(ii) Derive and show that RMS output voltage is expressed as $V_{rms} = 0.5V_m$. Hence, determine the RMS output current expression (I_{rms}).

[5 marks]

(iii) Determine the efficiency of this rectifier. [3 marks]

(iv) Sketch the one complete cycle for following waveforms:

1. Output voltage (v_o) [2 marks]
2. Diode voltage (v_D) [2 marks]
3. Output current (i_s) [2 marks]

Continued...

Question 3 [25 marks]

A boost converter operates at 250Hz under continuous conduction mode has 25 Ω load resistance, 150 V input voltage and 12 A average load current. Calculate the load inductance such that maximum load ripple current is limited to 10% of I_L.

(a) Sketch the circuit diagram for this converter. [3 marks]

(b) Calculate the value for output voltage and duty cycle. [4 marks]

(c) Determine the inductance value and current ratings of the inductor. [7 marks]

(d) Derive the equation for ripple factor. Hence calculate the capacitance value such that the ripple at output voltage is less than 1.5%. [6 marks]

(e) Draw the inductor current and inductor voltage waveforms. Clearly indicate all numerical values at the waveforms. [5 marks]

Question 4 [25 marks]

(a) Discuss **FOUR (4)** categories of inverters based on the types of AC output. [8 marks]

(b) A full bridge inverter with 120 V voltage source operating at 1.5k Hz with 60% duty cycle is connected to RL load with R=20 Ω and L=2mH. The Fourier Series expression for the instantaneous output voltage is given as:

$$v(\omega t) = \sum_{n=1,3,5...}^{\infty} \frac{4V_S}{n\pi} \sin\frac{nD\pi}{2} \cos n\left(\omega t - \frac{D\pi}{2}\right)$$

(i) Write the voltage expression for fundamental frequency component. [1 mark]

(ii) Determine for the following parameters:

1. RMS value of fundamental component ($V_{1,rms}$). [2 marks]
2. RMS value of total harmonic components ($V_{H,rms}$). [4 marks]
3. Voltage transfer ratio (T_{vv}). [2 marks]
4. Total harmonic distortion (THD). [3 marks]

(iii) Calculate the duty cycle value such that 3rd harmonics component is eliminated. [3 marks]

(iv) Draw the output voltage waveform for one complete cycle. [2 marks]

End of page.